DAB on a Dongle Stick

Free software turns cheap DVB-T USB sticks into DAB radios

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Since the switch-off of DVB-T and its replacement by DVB-T2 there have been long faces in several European countries where the original digital terrestrial television standard has been superseded. At a stroke, TVs and set-top boxes equipped only for DVB-T became useless junk and had to be replaced by new T2-compatible models. But one man's pain is another man's pleasure: masses of USB sticks capable of receiving only DVB-T were rendered obsolete and are consequently ludicrously cheap now (check out eBay). Using special software by the name of *Welle.io* many of these 'dongle sticks' can be turned into SDR (Software Defined Radio) devices that provide extremely passable DAB radio reception.

The shutdown of analogue television first to DVB-T and then DVB-T2 in order to fully exploit the 'digital dividend' (= make better use of the available bandwidth in the ether) highlights how technical progress can also cause collateral damage by making existing receivers no longer usable or at least not fully usable. Even lovers of classic audio broadcasting (i.e. radio) are affected by drastic changes. Many nations have announced or already implemented the replacement of analogue radio broadcasting by digital [1]. In some countries the sale of radio receivers without DAB capability will soon be no longer be allowed. There is also an increasing number of voices calling for the replacement of the broadcast of analogue modulated radio signals without compensation. In Germany the outcry would be great, because DAB simply cannot achieve this on its own and 97% of the German population still possess completely non-digital radio sets. The state would like to enforce a larger installed base before, for example, most road vehicle drivers will no longer be able to receive traffic updates.

That's technology for you! If people do not adopt DAB voluntarily, some administrative force will be required...

Why DAB?

No argument: DAB radio has no background noise and actually sounds pretty good, dependent mainly on the data rate on offer (typically between 48 and 112 kbit/s) — as good as CD quality sounds when streamed. Of course, this does not give you the same quality as lossless or at least low-loss compressed signals, but digital transmission certainly beats the sound quality of FM in many repects. In addition, significantly more digital channels can be squeezed into a specified frequency domain than would be the case with analogue. So everything is fine then and the legislature is

Figure 1. Two different DVB-T USB sticks with their remote controllers.

well advised to enforce the switch to digital broadcasting?

Where there's light you also find shadows. The main problem with digital broadcasting is that reception also behaves digitally: either it's there or it's not. At home this may be no big deal, because if you have reception problems, you just shift the antenna to make reception of the desired station (or stations, because they are bundled together in a number of groups called multiplexes) acceptable. On the road in your car things look different, however; if the field strength drops, so does the sound quality. Either the noise increases or reception switches into mono, as happens with VHF. In fact, below a certain threshold, reception is lost completely gone, especially with DAB+. If you are on the fringe of the transmission range the programme you're listening to can drop out for some seconds, then you hear it off and on again — and eventually nothing at all. This can be pretty annoying, especially since the full roll-out of the network will probably never be completed. Radio in its present form might even disappear completely and be replaced by Internet streams over mobile radio.

At home you are of course stationary and not mobile, so here these problems do not matter. And until radio is consigned to the scrap heap entirely, you can at least experiment with digital radio, especially since getting started with inexpensive USB sticks and suitable software involves very little outlay.

Stick selection

When Albrecht Lohöfener, the author of the Welle.io software, contacted the Elektor editorial team with news of his radio software for sticks, my curiosity was aroused. I rummaged around on the related website [2] and decided to get myself a cheap USB stick of this kind. The software supports more than just DVB-T sticks but these definitely make a good starting point. According to the website and information from Albrecht, virtually all DVB-T sticks are based around the Realtek RTL2832U chip [3]. The Internet is stacked with these sticks. Some of them include crystal-controlled stability and somewhat less expensive models come without this feature. The Welle.io software can handle both, as it can compensate automatically for the frequency offset of the oscillator.

So far, so simple. After some quick research I ordered a USB stick with 'improved R820T2 tuner' (at €25 / £22 / $30 somewhat expensive). This is the blue object in **Figure 1**. The device even has an SMA socket for connecting the antenna (!) and a small extensible telescopic antenna with a maximum length of 27 cm (see **Figure 2**). As a ¼-λ antenna this works out to an optimal frequency of around 275 MHz. This is not so very far off the 174 to 230 MHz of DAB-specific VHF Band III. These frequencies are thus notably higher than those used for FM radio, which makes for shorter transmission ranges and shorter antennas. In any case this telescopic antenna is better than the 13-cm long stub antenna

Figure 2. Telescopic antenna with magnetic base sold with the blue stick.

Figure 3. Stub antenna with magnetic base of the lower-priced white stick.

in **Figure 3**, which is supplied typically with cheaper DVB-T sticks and also with the white example in Figure 1.

If you are now wondering why I needed two sticks of this kind, I can explain. You see, initially I had difficulties getting the blue stick to perform. On the one hand, this was due to my lacklustre handling of drivers and, in part, to minor inconsistencies in the previous version (RC3) of Welle.io. But I can tell you straightaway

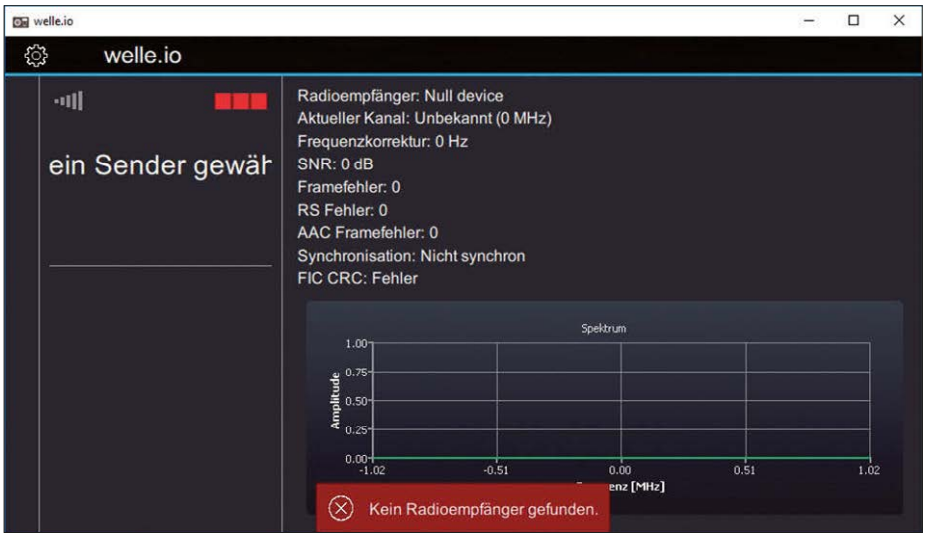

Figure 4. No stick detected = no reception (screenshot by Welle.io).

Figure 5. Using the final version 1.0 of Welle.io we detected a handsome number of transmitters.

that reception is brilliant if you use the current version of the software!

Trial and error

No sooner had the blue stick arrived than I installed the software on my computer, inserted the stick in a USB port on my PC and... to begin with, Welle.io did absolutely nothing!

Sure, a window popped up but all it said was that the stick could not be found. **Figure 4** shows the Expert View interface of Welle.io, with some technical information on reception and (if things were working) the graphical presentation of the spectrum of the signals being received. The superimposed red caption at the bottom of the screen was irritating. Reading the Welle.io website more carefully now helped; you need to install a driver first. Clearly, I had become far too accustomed to modern operating systems and their automatic installation of drivers. How you install the correct driver you can read on the website at *Hardware → RTL-SDR* and there for Windows in the *Windows Setup* section. Instead of the *RTL2838UHIDIR* device mentioned in the instructions I saw a *Bulk-In, Interface (Interface 0)*, which made no difference, however, because the driver could also be installed here. If you are too impatient, then you too will be punished by the malfunction ;-).

After a few clicks and restarting the software the spiteful red message disappeared and ergo, my blue stick was now recognised. But still no radio activity visible. Somewhere there must be a transmitter search function — or something of that kind. It took a while before I noticed that the white bar on the left could be shifted further to the right with the mouse and then a click on the wheel in the upper left corner brought to light the buttons that let you search for stations and make other settings. This was all down to the release candidate status of the software. Version 1.0 no longer plays hide-and-seek.

A transmitter search was now conducted and in fact a couple of stations were discovered and after clicking the Back button were displayed on the left-hand side in list format. Reception results were hardly intoxicating nevertheless. Sometimes you heard something, then the transmitter disappeared again. Initially I put this down to poor reception conditions in my office. So I fetched a USB extension cable and placed both the stick and antenna close to the window. Unfortunately this made no significant improvement. Perhaps there was something wrong with my stick.

Stick or software?

So I simply ordered a different stick. This time it was a cheap type. The white stick in Figure 1 came bundled with a remote control, a smallish antenna with a normal RF connector and a mini-CD with some no longer usable TV software. At €12 / £10 / $15 this was unimpressive. The stick was cobbled together very crudely and was not provided with a crystal for drift-free stability.

When I plugged it expectantly into a USB socket, there was no improvement in reception but equally it was not really any worse than with the blue example sold at twice the price. So, whatever was wrong could hardly lie in the stick itself.

Just when I was thinking of giving up, the final version 1.0 of Welle.io appeared. New opportunity, new joy? First, I deleted version RC3 from the SSD and installed version 1.0 instead. Yikes! Now my sticks were no longer recognised by the software! My suspicion that even the driver for the sticks had been updated was confirmed. In the ‘welle.io’ folder under ‘Programs (x86)’ of my Windows 10 installation instead of the driver installer ‘zadig-2.2’ there was now ‘zadig-2.3’. I installed the new driver, rebooted the PC anew as a precaution, stuck the stick in the socket and started Welle.io. Tada! The stick was detected.

A fresh search for transmitters now brought in a remarkable number of stations, as you can see from the list

in **Figure 5**. When I now clicked on a transmitter I was rewarded with stable audio in good quality. **Figure 6** shows reception of DLF Nova in Expert mode. Over on the right-hand side we see the signal spectrum in real time. As well as this there is plenty of detailed technical information for those who need this. On my PC the Expert View mode consumes one or two watts more than the simpler standard depiction. So far, so good then?

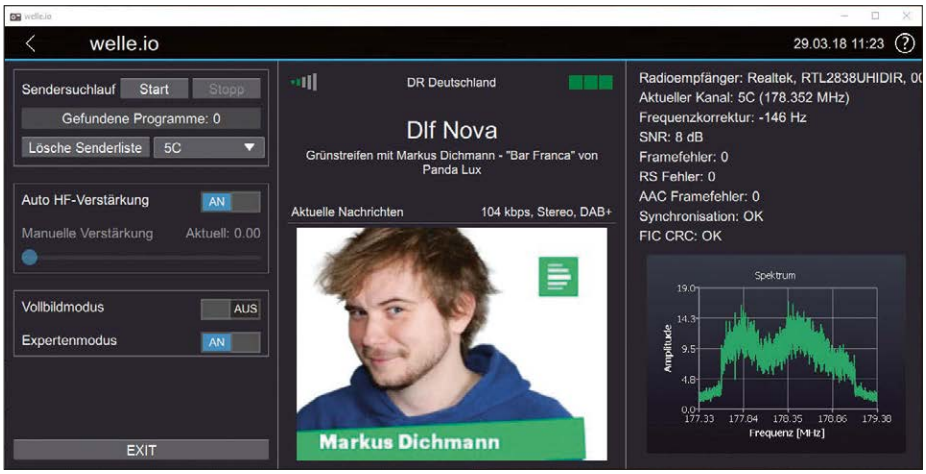

Figure 6. Despite low field strength, reception of DLF Nova is good. The screenshot illustrates Expert View mode.

Figure 7. Current consumption of the blue stick in DAB radio operating mode.

Experience gained

Reception is extremely good. This is remarkable, as my office is right on the edge of German territory, only around 4 km away from France as the crow flies. For me which stick I used made no great difference. Only the field strength of individual transmitters varied. This was occasionally one point below maximum with the white stick, whereas the blue stick indicated mostly maximum field strength — no wonder with its longer antenna.

However, I soon had new problems, because for some reason reception or a new channel search failed altogether. To check whether this could have something to do with loading the new driver without deleting the old one, I installed Welle.io and the drivers again onto a fresh Windows 10 system on my laptop. Lo and behold: everything perfectly in order — stable and interference-free reception at different corners of the house. Even with the short antenna and the cheaper stick, the reception was fine; just occasionally I had to position the antenna correctly.

All in all, the combination of a low-cost DVB-T stick and Welle.io will give you a good PC radio for little outlay. In my experience the blue stick has the edge on account of the antenna, even though it costs twice the price of the more basic white one.

And finally

In standby mode a DVB-T stick of this kind draws around 100 mA from the 5 V furnished by the USB interface, i.e. equivalent to 0.5 W. Active operation in radio mode increases its energy consumption. **Figure 7** shows the blue stick in action. At 5.2 V we have a current of 0.26 A flowing. That means the stick consumes 1.35 W. To this we should add the energy consumption of the PC on which Welle.io runs. I can also report here that Welle.io poses an additional requirement of about 5 W (over and above idle). However, this relates specifically to my PC, which is fitted with an i7-7700K CPU, which runs at around 4 GHz. On a laptop it would be somewhat less.

Before you ask, the little remote control zappers provided with DVB-T sticks do not work with Welle.io. Maybe you need to wait for a software update or else tackle the task yourself.

Welle.io is not only an easy-to-use Open Source program but it's also backed up by online instructionals, a small Wiki, and a user forum. If you wish, you can also contribute to its further development. The complete source code is available on the corresponding GitHub page.

Welle.io is not only for Windows. On Google Play there is also a version for Android and consequently for suitable mobile radio devices equipped with USB master interfaces. As well as the version for ARM-SoCs there is even one for x86 processors. In principle a standalone DAB radio (including display) can be created on a Raspberry Pi platform. The Windows version is available for download for installation in ready compiled form, whilst there is a 64-bit version for Linux x86. Implementations for OS X are circulating on the Internet as well. My experiments took place on the very latest 64-bit version of Windows 10.

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Web Links

[1] Digital radio switchover status: https://en.wikipedia.org/wiki/Digital_radio

[2] Welle.io software website: www.welle.io

[3] Realtek RTL2832U chip web page: https://bit.ly/1dtzV0T

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